Body dimensions of stream rearing juvenile bull trout and rainbow trout in tributaries of Chester Morse Lake Cedar River Municipal Watershed - November 2008

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Purpose

The primary intent of the study effort described below is to provide specific, on-site information on selected body dimensions of bull trout (*Salvelinus confluentus*) and rainbow trout (*Oncorhynchus mykiss*) in several juvenile age classes that rear in tributaries of the Chester Morse Lake/Masonry Pool reservoir complex, using individuals captured in several tributary systems during summer 2008 (July - September). The study also directly informs other biologists, SPU water supply managers, and consultants of these body measurements relative specifically to project planning and the design of 'fish screens' for the pumping plant intake structure currently being designed for installation and future use in Chester Morse Lake reservoir.

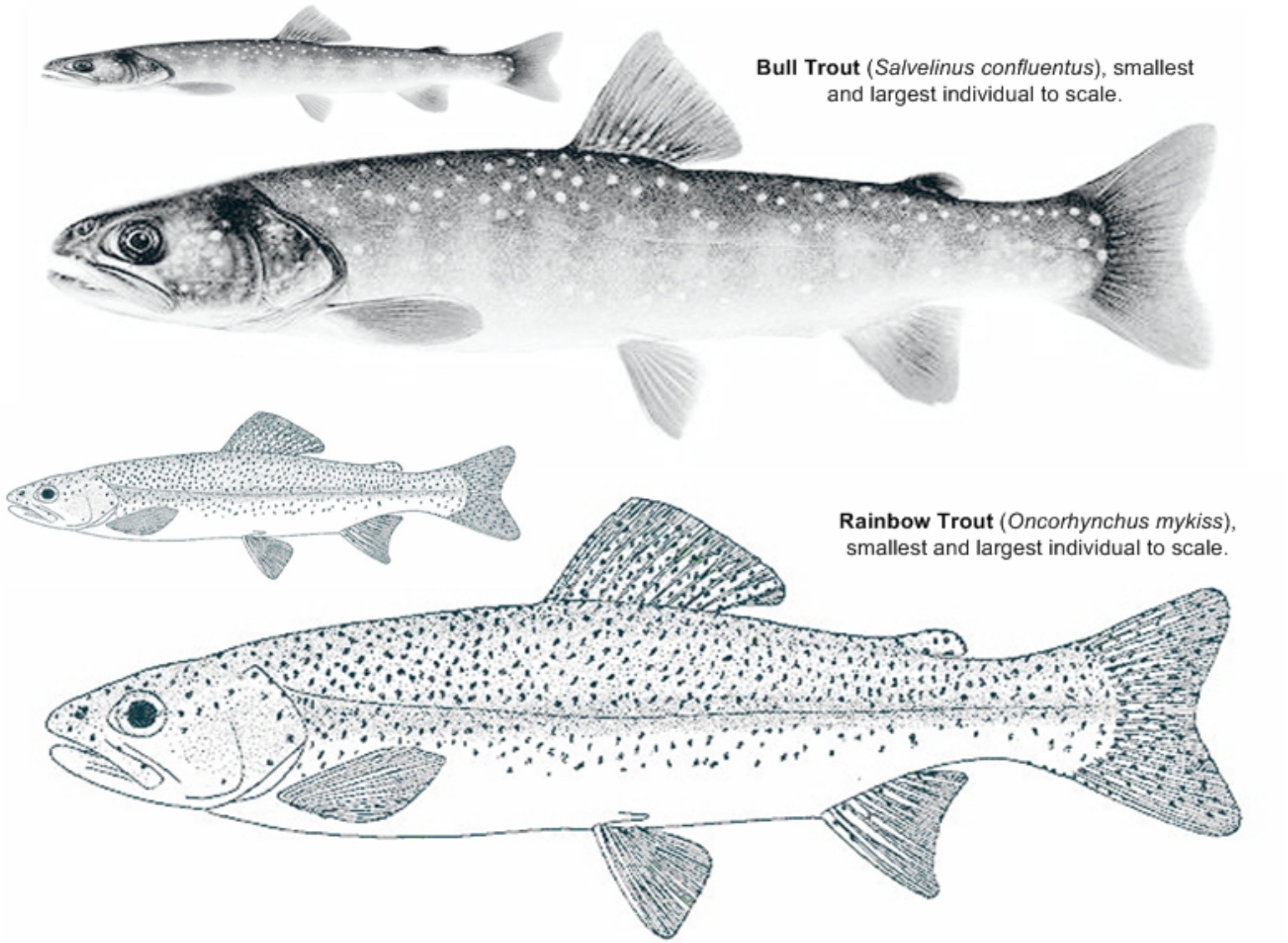
Background

Adfluvial bull trout and rainbow trout both spawn in tributaries of the Chester Morse Lake reservoir complex in fall and spring, respectively. Their offspring rear in these same tributaries for variable periods of time before some portion of individuals, especially bull trout, migrates to the reservoir to continue growth and maturation. The age at which fish move differs by individual and is likely influenced by environmental conditions (e.g., stream temperature, flow, etc.) as well. Recent data collected at PIT (passive integrated transponder) tag detection arrays in the upper Cedar River Municipal Watershed indicate that bull trout outmigrate at fork lengths between 80 and 230mm (Mesa et al. 2008), representing primarily age 1 and age 2 juvenile age classes. Fish in both of these age classes, as well as young of the year aged individuals, have been observed at the margins of the reservoir proper. Movement timing for rainbow trout is not well defined at this stage in the PIT tag study, likely because many rainbow trout exhibit a resident life history strategy and may never move to Chester Morse Lake.

Methods

In summer 2008, SPU Fish and Wildlife Unit staff with assistance from Forest and Channel Metrics, Inc. consultants captured juvenile bull trout and rainbow trout throughout known rearing habitat in tributaries of Chester Morse Lake. Selected body measurements were taken from a sub-sample (approximately 33% of all bull trout and 10% of all rainbow trout) of captured fish that fell between 80-230 mm fork length in order to assess variation in body dimensions and to generate representative cross-sectional profiles of juvenile bull trout and rainbow trout (Figure 5). We selected fish that were age 1 or older (>80mm fork length) for sampling. Body depth and width were measured immediately anterior to the dorsal fin, and length was measured as fork length (nose to notch in the caudal fin) (Figure 6 and 7).

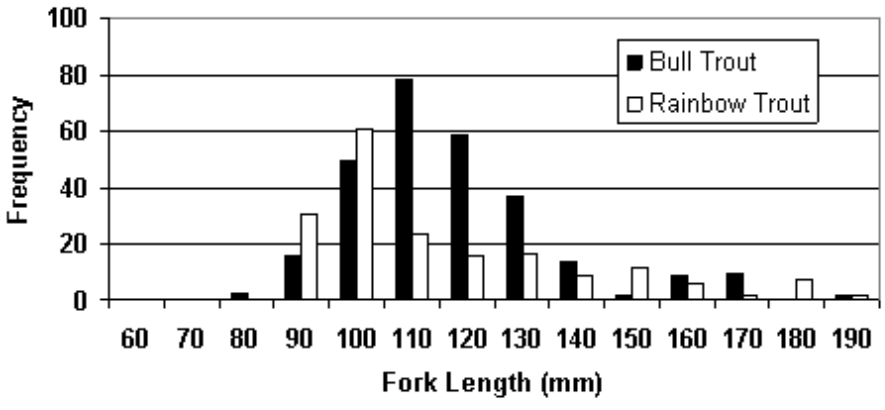
Figure 1. Smallest and largest individual bull trout and rainbow trout (drawn to scale).



Results

Fish from a wide range of fork lengths were included in our sample; however, substantially more individuals of each species fell within the range 100-130 mm fork length than in lower or upper portions of the overall fork length range (Figure 1 and 2). The mean fork length for juvenile bull trout was 113.7 mm (n=281) and the mean fork length for juvenile rainbow trout was 111.6 mm (n=189).

Figure 2. Fork length of juvenile bull trout and rainbow trout



Body depth and body width were quite variable for both species; however, overall distributions were similar, especially considering individual bull trout are several months older within a year class than representative rainbow trout during the sample period (Figure 3 and 4).

Figure 3. Body depth of juvenile bull trout and rainbow trout

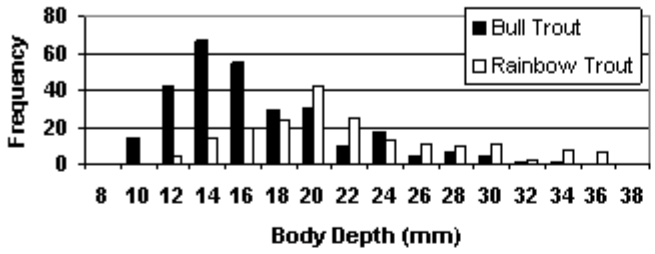
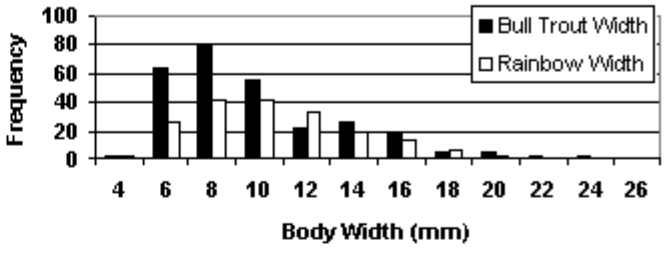
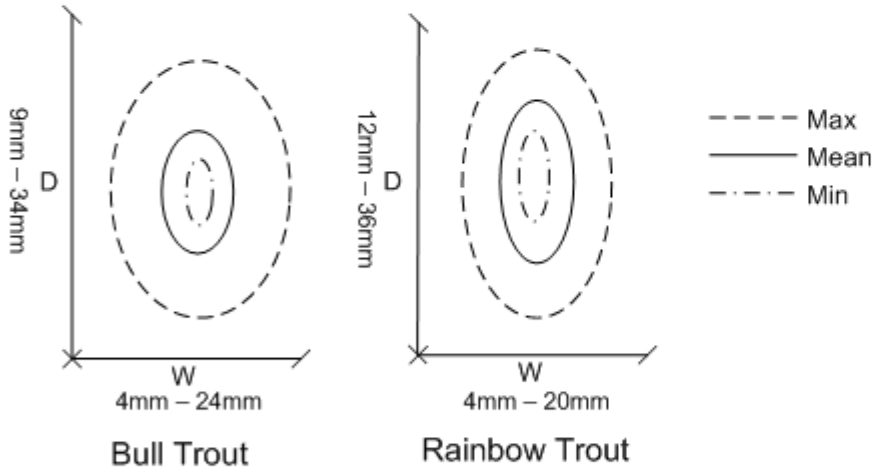


Figure 4. Body width of juvenile bull trout and rainbow trout



The overall range of cross-sectional dimensions was similar for the two species although cross-sectional profiles were somewhat different. Body depth averaged 16.2 mm (range 9 mm-34 mm) for bull trout and 21.5 mm (range 12 mm-36 mm) for rainbow trout. Body width averaged 9.3 mm (range 4 mm-24 mm) for bull trout and 10.0 mm (range 4 mm-20 mm) for rainbow trout (see Figure 5). Rainbow trout tended to have deeper and more narrow cross-sectional dimensions when compared to bull trout.

Figure 5. Cross-section (to scale) for juvenile bull trout and juvenile rainbow trout (all tributaries combined) (left). Maximum, mean and minimum body depth, body width and fork length provided below (right).



	Bull Trout	Rainbow Trout
Depth *n* =	281	189
Max D(mm)	34	36
Mean D(mm)	16.2	21.5
Min D(mm)	9	12
Width *n* =	281	189
Max W(mm)	24	20
Mean W(mm)	9.3	10
Min W(mm)	4	4
Fork Length *n* =	281	189
Max FL(mm)	181	185
Mean FL(mm)	113.7	111.6
Min FL(mm)	80	80

Discussion

Results in this study of body dimensions of young, rearing bull trout and rainbow trout indicate a substantially greater variability in selected body measurements than demonstrated by spawning pygmy whitefish (*Prosopium coulteri*) in a previous study. This variability can be attributed to differing growth patterns between stream systems and/or lake habitat during the first few years of the individual's life. All pygmy whitefish sampled during 2007 were reproductive adults with a mean fork length of 189 mm. One small individual (124 mm) was recorded during the sampling effort providing the minimum sized reproductive adult. It was concluded from that study that a screen size of 6.7 mm by 6.7 mm would prevent the smallest reproductive pygmy whitefish from becoming impinged by intake screens (Paige and Barnett 2007).

Figure 6. Average juvenile stream-rearing bull trout (*Salvelinus confluentus*) to scale.

Screen must be no larger than 6.5mm x 6.5mm (9.2mm diagonally) square mesh to prevent the average juvenile bull trout (age 1) from potential entrainment in mesh.

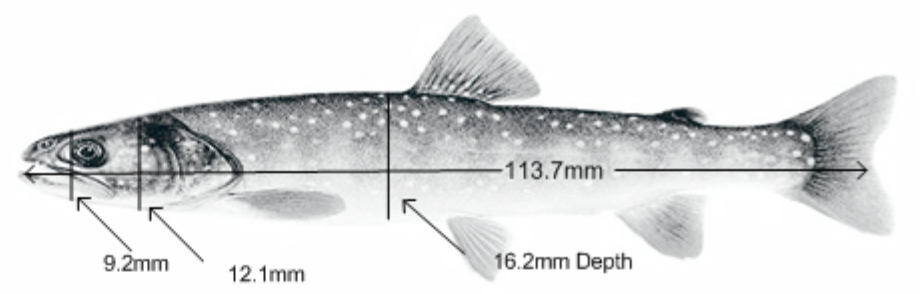
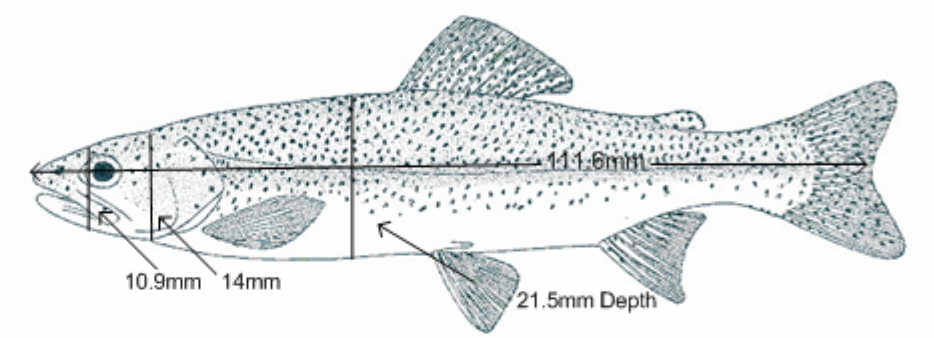


Figure 7. Average juvenile stream-rearing rainbow trout (*Oncorhynchus mykiss*) to scale.

Screen must be no larger than 7.7mm x 7.7mm (10.9mm diagonally) square mesh to prevent the average juvenile rainbow trout (age 1 or 2) from potential entrainment in mesh.



It is significant to recognize that the head of both juvenile bull trout and rainbow trout (anterior to the operculum) is slightly smaller in both depth and width than the body location where measurements were taken in this study (Figure 6 and 7). A screen mesh size that would allow the head of a fish, especially young fish, through to a point posterior to the operculum, despite not allowing passage of the entire body, would essentially entrain the fish. A fish so entrained would stand little chance of backing out from that point, and mortality would invariably result. Taking measurements in the head area (anterior to the operculum) of this age/size class of fish would substantially increase risk to sensitive organs and possibly result in mortality. Also, such measurements would be substantially less consistent. We provide a measured estimate of body depth in the head region for both species based on measurements from diagrams (Figure 6 and 7) allowing application of our information to the design of intake screens (i.e., mesh size) for the proposed pumping plant.

Our data show that a mesh size of 6.5 mm by 6.5 mm would screen for an average fork length juvenile (age 1) bull trout. This mesh size would not be small enough to screen for young of year bull trout or smaller than average age 1 individuals (Figure 6). Similarly, a screen size of 7.7 mm by 7.7 mm would reduce the likelihood that an average sized age 1 or 2 juvenile rainbow trout would become entrained in the mesh. As for bull trout, a mesh of this size would not protect young of the year rainbow trout and small age 1 individuals (Figure 7). Prior to this study, the pygmy whitefish sampling effort found that a mesh size of 6.7 mm by 6.7 mm would adequately protect the smallest reproductive adults (Paige and Barnett 2007). In summary, the mesh dimensions indicated for protection of average size, young bull and rainbow trout are very similar and consistent with those indicated for protection of small, adult pygmy whitefish (i.e., 6.5mm, 7.7mm, and 6.7mm, respectively).

References

Mesa, M.G., P.J. Connolly, N.A. Zorich, L.K. Weiland, H.K. Barnett and D.K. Paige. 2008. Juvenile bull trout and rainbow trout movements and growth in selected tributaries of the Chester Morse Lake basin, Cedar River Municipal Watershed, Washington. Final report prepared for SPU.

Paige, D. and H. Barnett. 2007. Body dimensions of pygmy whitefish (*Prosopium coulteri*), Chester Morse Lake, Cedar River Watershed. December 2007. White paper prepared for SPU internal use.